GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station

PROJECT INITIATION

Date: 2/23/72

Project Title: Development of Scanning Auger Electron Spectrometer System

Project No.: B-402

Project Director: Dr. E. J. Scheibner

Sponsor: Owens-Illinois

Effective January 1, 1972 Estimated to run until: December 31, 1972

Type Agreement: Grant Amount: $ 5,500

Reports: Progress Report concerning use of Grant.

Contact Persons: Dr. H. G. Slottow
Dr. D. C. Hinson
Owens-Illinois
General Offices
Toledo, Ohio 43601

Assigned to Physical Sciences Division

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PROJECT TERMINATION

Date September 24, 1973

PROJECT TITLE: Development of Scanning Auger Electron Spectrometer System

PROJECT NO: B-402

PROJECT DIRECTOR: L. N. Tharp

SPONSOR: Owens-Illinois

TERMINATION EFFECTIVE: April 11, 1973

CHARGES SHOULD CLEAR ACCOUNTING BY: All charges cleared

Final Report Distributed 4-11-73

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B-402

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

April 9, 1973

Owens-Illinois
General Office
Toledo, Ohio 43601

Attention: Dr. H. G. Slottow

Subject: Final Report for Project B-402
"Development of Scanning Auger Electron Spectrometer System"

The Scanning Auger Spectrometer was conceived as a unique instrument for surface analysis which combines the topological information of a high-resolution scanning electron microscope with the chemical identification of surface species by Auger spectroscopy. The initial design was then formulated using an available vacuum system and the heart of the field emission electron source obtained from Argonne National Labs. The spectrometer developed under this grant was then largely constructed from these two systems.

From the beginning of this work it was realized that two uncertainties existed with the use of this equipment. One was whether or not the ultra-high vacuum system on the LEED/AUGER unit has sufficient pumping capacity to take care of the additional gas load imposed by the scanning unit. The other was whether or not a field emission electron source could produce a sufficiently intense beam to generate measurable currents of Auger electrons.

With regard to the vacuum system, the plumbing has been rearranged and a large titanium sublimation pump added. Providing the instrument is baked at 250° C for 24 hours after each cycle to atmospheric pressure, the ultimate pressure in the vacuum chamber can be in the low 10^{-10} torr range. However, this pressure increases by as much as an order of magnitude during thermal conditioning of the field emission tip. The overall vacuum situation makes for unstable electron optical performance. A great amount of time has been spent trying to obtain stable field emission in this instrument, but only on several isolated occasions has this been achieved.

The total current that can be obtained from a field emission source, under stable operating conditions, is between 10^{-6} and 10^{-7}A. After passing through several lens systems, which are required to accelerate and then focus the beam into a small spot, the beam current available at the specimen is between 10^{-9} and 10^{-10}A. A beam current of this magnitude is quite adequate to generate scanning electron microscope images, even when using the generated specimen current to modulate the image forming raster, and, indeed, several acceptable micrographs have been made with the instrument.

Difficulty has been experienced, however, in using such weak primary beams to generate Auger electron spectra for detection with a spherical grid retarding potential spectrometer. This fact can be appreciated when one considers that the Auger electron yield is only about .001 of the primary electrons. In addition, the second derivative of this secondary electron current is being used to actually generate the spectrum. This leads to a further reduction in signal intensity.

The Auger electron signal generated in this type of spectrometer is low level, associated with considerable system noise which is due to the inherently noisy grids along with the fact that no amplification is afforded at the signal source. Its potential to generate meaningful Auger data is at best, marginal and the situation is further degraded when the poor long-term stability feature of a field-emission source is also considered.

A vast improvement can be gained in Auger electron signal detection by substituting a cylindrical mirror spectrometer for the spherical grid spectrometer. This type of spectrometer is inherently less noisy than the grid type, has a large acceptance angle and the voltage analyzed signal is amplified by 10^{6} to 10^{8} by means of an electron or photomultiplier. The output signal intensity is similar to that obtained from the scintillator detector used in a conventional scanning electron microscope, when arranged to detect secondary electrons.

This grant has enabled us to gain much insight into the problems inherent in a Scanning Auger Spectrometer and the support of Owens-Illinois is greatly appreciated.

Respectfully submitted,

[redacted]

Edwin J. Scheibner
Project Director

EJS:brj

xc: Dr. D. C. Hinson